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Sugar

The Economics of Bioethanol Production in the EU

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Report Highlights:
This report explores demand, supply, and production of bioethanol from sugar beets and wheat in the EU. Sugar beets prove to be a good feedstock for European bioethanol production. Because sugar beets have a much larger yield per hectare than wheat, the EU currently produces 2 million more tons of sugar beet than wheat on 20 million less hectares of land. Additionally, sugar beets produce more ethanol per hectare: a hectare of sugar beets can produce 30 hectoliters more ethanol, on average, than wheat. Also, sugar beet ethanol is shown to have a more energy-efficient production process than wheat ethanol and promises greater greenhouse gas reductions. This is the first in a series of reports about ethanol production in the EU.

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Introduction

Alternative fuels are a widely discussed topic as of late for multiple reasons. Firstly, there is the fact that it is undesirable, particularly in reference to national security, to be dependent on foreign nations for energy. For the EU, which reported in 2000 that it imports 75% of its oil supplies, anticipates that oil imports will exceed 85% by the year 2020, and relies on petroleum for 98% for its transport fuels, this is a valid concern.[i] Secondly, there is the fact that demand for fuel is growing. Between 1985 and 2004, road transportation fuel consumption in Western Europe (primarily the EU) grew by nearly 50%.[ii] In 2004, Western Europe consumed over 270 million metric tons, or approximately 89 billion gallons, of road transportation fuel — 60% as diesel fuel and 40% as gasoline. With a significant and growing demand for fuel, efficiently produced alternative fuels are becoming a necessity. Thirdly, alternative fuels created from biomass, biofuels, can work in the interests of farmers and rural development. They can expand the uses for crops and make the work of an energy crop farmer profitable. For these reasons, alternative fuels, particularly biofuels, have a promising future in the European Union.

Executive Summary

Bioethanol presents a strong alternative to petroleum in the European Union. Before exploring the details of bioethanol production, it is important to remember two of the EU's current commitments: one, under Directive 2003/30/EC, the European Commission has set a guideline for biofuels to account for 5.75% of all transport fuels by 2010[iii], and two, under the Kyoto Protocol, the EU has committed to an 8% reduction of carbon dioxide emissions by the end of 2012.

This paper will explore demand, supply, and production of bioethanol from sugar beets and wheat in the EU. In terms of demand for road transportation fuels, the EU's Directorate for Energy and Transportation estimates that between 2000 and 2030, the EU-25 will experience an increase in dependency on energy imports, from 47.1% in 2000 to 67.5% in 2030. It predicts that private cars and motorcycles will remain the most important means for personal transport, with a market share of 75.8% in 2030, and the largest increase in fuel use for transport will be from trucks. As demand for fuel is forecast to grow rapidly, the EU needs to keep in mind its target of biofuels accounting for 5.75% of all transport fuels by 2010. If the Member States comply with these guidelines, the bioethanol market is estimated to grow to between 8 and 10 million tons per year by 2010. The EU has seen its production of bioethanol grow 15.6% over the course of one year, from 424,750 tons in 2004 to 491,040 metric tons in 2005. Bioethanol from sugar beets and wheat can prove to be effective transition fuels during this time of growing energy demand.

In terms of feedstock supply in the EU, wheat and sugar beets are the two crops relevant to bioethanol production. In 2004, Member States produced 131 million tons of sugar beets and 138 million tons of wheat.[iv] In the same year, EU production of bioethanol used about 1.2 million tons of cereals and 1 million tons of sugar beet. This indicates that 0.4% of total cereals and 0.8% of sugar beets went toward bioethanol production.[v] As these are very small percentages of production, it seems that there is room for expansion of the grain- and sugar– to-ethanol production processes. There is further reason to believe that sugar will be easier to obtain in the future, due to a reform of the European Sugar Market Organization. As of July 2006, sugar beet production will qualify for both set-aside payments when grown as a non-food crop and for the energy crop aid of 45 euro per hectare on non-set-aside area; and, sugar used for the production of bioethanol will be excluded from sugar production quotas.

In this report, sugar beets prove to be a good feedstock for bioethanol production in the EU. Because sugar beets have a much larger yield per hectare than wheat, the EU currently produces 2 million more tons of sugar beet than wheat on 20 million less hectares of land. Additionally, sugar beets produce more ethanol per hectare: a hectare of sugar beets can produce 30 hectoliters more ethanol, on average, than wheat.

In terms of the conversion process, two studies bring insights in this area. In comparison to gasoline production, one study shows that bioethanol production is more energy efficient than gasoline production. This is because the energy contained in the crops has used solar energy to grow. A second study compares the conversion of sugar beet-to-ethanol and wheat-to-ethanol and finds the sugar beet-to-ethanol conversion process to be more energy efficient.

In terms of production costs, wheat-to-ethanol production is slightly less expensive than sugar beet-to-ethanol production. The feedstock prices and co-product values are very influential in this calculation. All consulted studies agree that the processing costs are slightly more expensive for wheat than sugar beets. Points of dissent among studies regard the value of the co-product from wheat and the cost of distribution sugar beet ethanol as opposed to wheat ethanol. These factors are very specific and deserve further attention in a later study of the ethanol production process in the EU.

Overview of the Bioethanol Production Process

To produce bioethanol, the raw products can be any crops that contain sugars. In the European Union, the most plentiful sources of sugars are sugar beets and wheat. The first step in the bioethanol production process is to extract the sugar from the crops. For sugar beets, a process of crushing, soaking, or chemical treatment can remove the sugar. In the production of sugar from sugar beets, molasses, a sugar-containing syrup, is formed as a rest product. Molasses can also be used as a sugar source in the ethanol production process. For wheat, the starch is transformed into sugar (glucose) with the help of enzymes. Once the sugar or molasses has been removed from the wheat and sugar beets, the production process is the same for both crops. The second step is for the sugar to undergo a fermentation process. Using yeast, the sugar is converted to alcohol. The third step is distillation to obtain the alcohol. The fourth step is rectification to attain the desired alcohol concentration. In creating ethanol from sugar beets, a co-product is vinasse, which is stored and sold to the feed industry as a component of livestock feed.[vi] In creating ethanol from wheat, the co-product is Distillers Dry Grain Soluble, which can be used as a source of energy for the production process or can be sold as a protein-rich animal feed.[vii]

Demand Side of Ethanol Production in the EU

The European Union's Directorate General for Energy and Transport (DG TREN) created a report in 2003 titled "EU25 – Energy and Transport Outlook to 2030." This report provides insight into future demand for fuels in the EU. DG TREN estimates that between 2000 and 2030, the EU-25 will experience an average annual growth in demand of 0.6% for primary energy (0.9 % for final energy), compared to 2.4% increase for GDP; and an increase in dependency on energy imports, from 47.1% in 2000 to 67.5% in 2030. They foresee private cars and motorcycles remaining the most important means for personal transport, with a market share of 75.8% in 2030, compared to 77.7% in 2000; and the largest increase in fuel use for transport in absolute terms is expected to be for trucks. After 2010 the fuel demand by trucks is forecast to even exceed that for passenger cars and motorcycles.[viii] These predictions show that demand for fuels for cars and trucks will continue to grow substantially. Knowing that gasoline and diesel fuels are limited, non-renewable resources, it is obvious that there will be a significant market for biofuels. Using ethanol as an ethanol-gasoline mix, there is no need to convert current car engines, which makes this a promising transition fuel.

Production of bioethanol in the EU grew 15.6% over the course of one year, from 424,750 metric tons in 2004 to 491,040 metric tons in 2005.[ix] Directive 2003/30/EC sets a guideline for biofuels to account for 5.75% of all transport fuels by 2010. If the Member States comply with these guidelines, the bioethanol market is estimated to grow to between 8 and 10 million tons per year by 2010.[x] While Member States have submitted their individual biofuel goals, many are not striving for a percentage as high as 5.75%. MS have established goals to increase biofuel use in the transport sector nonetheless; thus demand is surely expected to increase, although likely not to these levels.

Supply Side of Ethanol Production in the EU

Production of Bioethanol:

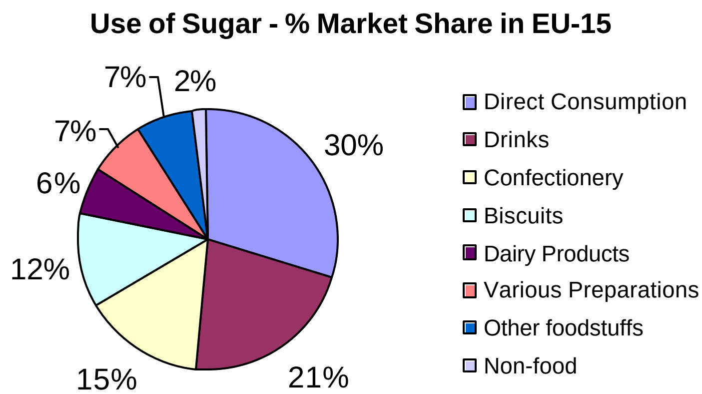
Production of bioethanol, from sugar beets and wheat, in the EU in 2005 was almost 500,000 metric tons. Production grew 15.6% over the course of one year: from 424,750 tons in 2004 and 491,040 tons in 2005.[xi]

Production of Feedstocks:

	Harvested	Yield	Production
Sugar Beets in EU	2.2 million hectares (in 21 MS)	57.4 tons per hectare	126 million tons
Wheat in EU	23 million hectares (in 25 MS)	5.4 tons p er hectare	124 million tons

Source: FAO Statistics, 2005

It is clear that Member States have much more land dedicated to harvesting wheat than sugar beets. However, the sugar beet yield per hectare is more than ten times greater than that of wheat. So, in terms of total production, the EU-25 produces 2 million more tons of sugar beet than wheat on 20 million less hectares of land.



Source: DG Agriculture, Sugar Infopack[xii]

The European Commission has reported that in 2004, EU production of bioethanol used about 1.2 million tons of cereals and 1 million tons of sugar beets. Therefore, 0.4% of total cereals and 0.8% of sugar beets went toward bioethanol production.[xiii] These are very small proportions of land being dedicated to bioethanol. For an idea of what other purposes sugar production goes to, the pie chart is included. However, as this chart is for the EU-15 and pre-sugar sector reform, it is only a general idea. There is significant potential, and several incentives, for increased energy crop production.

Potential For Change in Sugar Production:

As reported by FAS/USEU[xiv], on February 20, 2006, the EU adopted significant reform measures for its sugar sector, including a 36% cut in the internal sugar support price, elimination of the intervention system of sugar purchases, and partial sugar production quota buyback. The sugar reforms could impact biofuel feedstock availability since they substantially reduce internal sugar beet production incentives. However, much of the potential decline in sugar production could be offset by a drop in EU sugar exports which are restricted to not more than 1.273 MMT annually (compared with an estimated 7.1 MMT in 2005/06).

In addition, two reform provisions are likely to positively impact the availability of sugar beets as a biofuel feedstock: first, sugar beet production now qualifies for both set-aside payments when grown as a non-food crop and for the energy crop aid of 45 euros per hectare on non-set-aside area; and second, sugar used for the production of bioethanol will be excluded from sugar production quotas.

Production Efficiency of Bioethanol From Wheat and Sugar Beets

Estimates from European Studies on Ethanol Production Efficiency :

	Average Ethanol Production Efficiency	**Fuel Process Energy Efficiency** (energy in/out)	**Well-to-wheels GHG Emissions** (compared to gasoline vehicle per km traveled)
Wheat-to-Ethanol (based on 5 studies, '93, '93, '94, '96, '00)	356 liters/ton of feedstock	.91 Input: 136.5 e.u. Output: 150.0 e.u.	19% → 47% reduction (average 32%)
Sugar beet-to-Ethanol (based on 4 studies, '93, '93, '94, '02)	86 liters/ton of feedstock	.67 Input: 100.5 e.u. Output: 150.0 e.u.	35% → 56% reduction (average 46%)

Source: International Energy Agency[xv]
e.u. = energy units

This chart provides a substantial amount of information about ethanol production. Wheat, which has an average yield of 5.4 tons per hectare in the EU, produces an average of 356 liters of ethanol per ton of feedstock. This would enable the production of about 2000 liters (20 hectoliters) of ethanol per hectare of wheat in the EU.

Sugar beet, which has an average yield of 57.4 tons per hectare in the EU, produces an average of 86 liters per ton of feedstock. This would enable the production of about 5000 liters (50 hectoliters) of ethanol per hectare of sugar beets in the EU.

The European Biomass Industry Association makes data on "potential bioethanol yields" for EU Member States available on its Web site. For ethanol production from common wheat, the average liter per hectare yield is 1,700 (17 hectoliters) – ranging from 2,996 in Ireland to 499 in Portugal. For ethanol production from sugar beets, the average liter per hectare yield is 5,200 (52 hectoliters) – ranging from 7,980 in France to 2,964 in Lithuania.[xvi] These estimates lead us to believe that the calculations above made from FAO and IEA data should be accurate.

Energy Efficiency:

In terms of energy efficiency, we see that sugar beet-to-ethanol conversion is a more efficient process that wheat-to-ethanol. For example, if the goal is to produce 150 energy units from ethanol, it would take an input of 136.5 energy units to achieve this from the wheat conversion process but an input of only 100.5 energy units to achieve this from the sugar beet conversion process.

IEA, which gathered the data for the above table, notes that case studies that estimate better process efficiencies also tend to have greater greenhouse gas reduction estimates. They explain that "the feedstock-to-ethanol conversion plant efficiency is an important factor in determining the overall process energy use, as it determines how much feedstock must be grown, moved, and processed to produce a given volume of ethanol."[xvii] IEA also determined that the fossil fuel energy used in production rarely amounts to more than 20% of the energy contained in the final ethanol fuel, so that production and use of one liter of grain ethanol typically displaces about 0.8 or more liters of gasoline, on an energy-equivalent basis.[xviii]

A Second Opinion on Energy Efficiency:

A study conducted by ADEME/DIREM in 2002 provides another look at fuel process energy production efficiencies. It also compares energy input into ethanol and gasoline production. The study looks at all of the production stages between the extraction of raw materials and the distribution of fuels. Thus, the main stages of production taken into account for conventional fuels are: crude oil production, crude oil transport, the refining process, and product transport; and for biofuels are: cultivation (energy input and fuel consumption), feedstock transport to biofuel production plants, industrial processing (energy consumption and greenhouse gas emissions), and product transport.[xix]

The major finding of this study was that the energy efficiency ratios (released energy:non renewable used energy) of wheat and sugar beet ethanol chains are 2:1, in comparison with the value of the gasoline chain which is 0.87:1. This means that, considering the production stages outlined in the above paragraph, to create 150 units of wheat- or sugar beet-derived ethanol energy, 73 units of non-renewable energy must be used in the process. To create 150 units of gasoline energy, 184.5 units of non-renewable energy must be used in the process. This is explained by the fact that all of the energy used to grow the crops and most of the energy potential contained in the ethanol is from solar energy, a non-renewable energy source, while all of the steps of the gasoline production process are fossil fuel intensive. The study went further to analyze the stages of the fuel production chains. "For the wheat-to- and sugar beet-to- ethanol production chains, the agricultural stage contributes only 20% to the energy balance. The stage of industrial processing (processing of wheat and sugar beet into ethanol) contributes about 80% of the balance. The transport stages hardly contribute to the energy balances (less than 5%). Concerning gasoline networks, it appears that the refinery phase represents 60% of the gasoline energy balance. The phase of petroleum extraction contributes 30% to the gasoline energy balance. The transport stages represent about 10% of the energy balances." Here we see that the first step in the production chain is more costly for gasoline than for bioethanol. However, we see that the processing/refining step for the two fuels is similarly the most energy-intensive step of the process. Achieving efficiency in this step is most challenging and most essential.

Greenhouse Gas Reductions:

A last aspect of this production process is the greenhouse gas (GHG) reductions that are expected to result from the consumption of bioethanol as opposed to gasoline. IEA shows us that both ethanol feedstocks promise reductions. Wheat and sugar beets, as plants, absorb carbon dioxide as they grow. The ADEME/DIREM study explains, " The carbon dioxide emitted into the atmosphere during the combustion of biomass products does not contribute to the greenhouse effect. This emitted carbon had been previously absorbed from the atmosphere by the plant during its growth." While the ADEME/DIREM study determined the sugar beet and wheat to ethanol production efficiencies to be the same, the IEA study shows a difference in GHG reductions achieved from the two feedstocks. According to the IEA data sets, a 19 to 49% GHG reduction for every kilometer traveled, compared to a gasoline vehicle, can be expected for wheat-based ethanol. A 35 to 56% GHG reduction for every kilometer traveled, compared to a gasoline vehicle, can be expected for sugar beet-based ethanol. Thus, it appears that sugar beets have a greater capacity for greenhouse gas reduction, perhaps because of their higher yield per hectare.

Production Costs of Bioethanol From Sugar Beets and Wheat

IEA: Engineering Cost Estimates for Bioethanol Plants in Germany (US Dollars Per Liter)

Plant Capacity	50 Million Liters		200 Million Liters	
Raw Material	**Wheat**	**Sugar Beet**	**Wheat**	**Sugar Beet**
Feedstock cost	$0.28	$0.35	$0.28	$0.35
Coproduct credit	$0.07	$0.07	$0.07	$0.07
Net Feedstock Cost	**$0.21**	**$0.28**	**$0.21**	**$0.28**
Labor Cost	$0.04	$0.04	$0.01	$0.01
Other Operating and Energy Costs	**$0.20**	**$0.18**	**$0.20**	**$0.17**
Net Investment Cost	$0.10	$0.10	$0.06	$0.06
Total	$0.55	$0.59	$0.48	$0.52
Total Gasoline-per-Equivalent Liter	**$0.81**	**$0.88**	**$0.71**	**$0.77**

Source: International Energy Agency, 2004; Data Source: F.O. Licht's, 2003

BTG: Bioethanol production costs in the EU-25, Bulgaria and Romania

Raw Material	**Wheat**			**Sugar Beet**		
	€/L	€/GJ	€/toe	€/L	€/GJ	€/toe
Feedstock cost	0.40	18.90	790.00	0.26	12.30	513.00
Coproduct credit	0.15	7.10	296.00	0.03	1.40	59.00
Net feedstock cost	**0.25**	**11.80**	**493.00**	**0.23**	**10.90**	**454.00**
Conversion costs	**0.28**	**13.30**	**553.00**	**0.22**	**10.40**	**434.00**
Blending costs (incl. adaptation of gasoline)	0.05	2.40	99.00	0.05	2.40	99.00
Distribution costs	0.01	0.50	20.00	0.10	4.70	197.00
Total costs at petrol station	**0.59**	**27.90**	**1165.00**	**0.60**	**28.40**	**1184.00**

Source: Biomass Technology Group (BTG), 2004, as published on EUBIA Web Site[xx]

The above two production cost analyses, from IEA and BTG, facilitate understanding of the economics of ethanol production. In terms of feedstock cost, the most recent feedstock prices reported by F.O. Licht's (April 2006) were 24.10 €/ton for sugar beet and 110 €/ton for feed wheat.[xxi] The BTG study based their work on 140 €/ton wheat and 26.2 €/ton sugar beet prices. Thus, in the BTG study, the sugar beet prices are rather accurate but the wheat prices are a bit high. The BTG numbers for feedstock cost seem to be more accurate overall, however, than the IEA study, because IEA shows sugar beets as a more expensive feedstock than wheat and we have found the opposite to be true.

In terms of co-product credit (the value the by-products from ethanol production have), the studies differ greatly in their assessments. The IEA study gives equal, 7 cent, credits to both the wheat-to-ethanol and beet-to-ethanol processes. However, the BTG study gives the wheat process a 15 cent credit and the beet process a 3 cent credit. Differentiating credits like this makes more sense: the wheat-to-ethanol process creates Dried Distillers Grains Soluble (DDGS), which is valuable as a source of fuel or high-protein animal feed, while the by-product of sugar beet ethanol is sugar beet pulp, which can be used in animal feed.[xxii] It is clear that DDGS is a more valuable co-product than sugar beet pulp and thus should be credited that way. In terms of net feedstock cost (factoring in the original cost and the co-product credit), IEA continues to see sugar beets as the more expensive feedstock while BTG sees the costs of wheat and sugar beet becoming practically equal, 25 and 23 cents per liter respectively, and probably completely equal if we consider that wheat is currently less expensive than the base price for this study.

Next, in terms of processing costs (considering labor, energy, and factory operation), the two studies agree that wheat-to-ethanol processing is a bit more expensive than sugar beet-to-ethanol processing. The BTG study considers distribution costs and finds them to be significantly higher for sugar beet ethanol than wheat ethanol. It is unfortunate to not have a comparison with the IEA study on this factor. If we reference the ADEME/DIREM study, it concluded that transport costs for any bioethanol "hardly contributed to the energy balance", so this distinction of higher transportation costs for sugar beet ethanol is unexpected. A supposition for this factor is that wheat is grown in all 25 Member States while sugar beets are grown in 21 and some do not have a large yield. So, if sugar beet production is more spread out, perhaps distribution costs are higher for this product due to the need to transport the fuel farther to sell it.

In the end, IEA finds sugar beet ethanol production to be 6 cents more costly than wheat ethanol, per liter of gasoline equivalent. BTG finds sugar beet ethanol production to be 1 cent more costly than wheat ethanol. Considering the fact that the cost of wheat feedstock is currently less expensive than calculated by BTG, sugar beet ethanol would probably be more than 1 cent more costly than wheat ethanol. It is interesting that both studies come to the same conclusion: that wheat-to-ethanol production is slightly less expensive than sugar beet-to-ethanol production. In drawing that conclusion, the feedstock prices and co-product credits were very influential. The processing costs were similarly slightly more expensive for wheat than sugar beets in both analyses. The higher distribution costs for beet ethanol than wheat ethanol, considered only by BTG, were not explained by the study's authors, and definitely deserve a second consideration or a further explanation in a future study.

Conclusion

This review of bioethanol production studies clarifies the fact that wheat-based and sugar beet-based ethanol production are viable options for the European Union. Firstly, the demand for biofuels in the EU is strong, spurred both by the Commission's biofuels goals and by the growing demand for transport fuels. In terms of supply, the technology for ethanol production exists in the EU today and its efficiency improves as production expands. Only a small percentage of EU cropland is currently used for bioethanol feedstock crop production: 0.4% of total cereals and 0.8% of sugar beets went toward bioethanol production in 2004. With changes in the Sugar Market Organization, increased production of sugar beets for energy purposes is very likely.

Overall, sugar beets and wheat are both viable biofuel feedstock options for the EU, but it can be argued that sugar beets are the better option. Firstly, their yield, 57.4 tons per hectare, is over ten times the yield from wheat. While the liters of ethanol per hectare yield from sugar beets is significantly less than that of wheat, sugar beets still produce more ethanol overall due to the tons per hectare yield. IEA found the sugar beet-to-ethanol fuel process energy efficiency to be better than that of wheat, and beet ethanol production's estimated greenhouse gas emission reductions are greater than those from wheat ethanol. In terms of the production process, it was found that the wheat-to-ethanol production is slightly less expensive than sugar beet-to-ethanol production. However, the cost of sugar beet ethanol distribution in the IEA's cost analysis was the factor that brought the cost of beet ethanol production above that of wheat ethanol, yet the difference was not explained in the study, nor was it a similar finding in any other studies. Thus overall, the costs of wheat-based and sugar beet-based ethanol can be weighted similarly, although certain advantages remain for using sugar beets.

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[i] DG TREN. "The European Union's Oil Supply." 4 October 2000. Available: http://ec.europa.eu/energy/oil/doc/2000_10_oil_supply_en.pdf.
[ii] Schnepf, Randy. "European Union Biofuels Policy and Agriculture: An Overview." Congressional Research Service. 16 March 2006. Available: http://www.usembassy.it/pdf/other/RS22404.pdf
[iii] Directive 2003/30/EC of 8 May 2003; published in Official Journal L 123/42.
[iv] FAO Statistics 2004. Available: http://faostat.fao.org/faostat/form?collection=Production.Crops.Primary&Domain=Production&servlet=1&hasbulk=0&version=ext&language=EN
[v] EC Memo/06/65. "Biofuels Strategy: Background Memo." Available: http://europa.eu.int/rapid/pressReleasesAction.do?reference=MEMO/06/65&format=H TML&aged=0&language=EN&guiLanguage=en
[vi] Nedalco. "Production Process." Available: http://www.nedalco.com/index2.html
[vii] International Energy Agency. "Biofuels for Transport: An International Perspective." 2004. Available: http://www.iea.org/textbase/np pdf/free/2004/biofuels2004.pdf.
[viii] DG TREN. EU25 – Energy and Transport Outlook to 2030
[ix] Biofuels Research Advisory Council. "Biofuels in the European Union: A Vision for 2003 and Beyond." March 14, 2006. Available: http://europa.eu.int/comm/research/ energy/pdf/draft_vision_report_en.pdf.
[x] UEPA: European Union of Ethanol Producers. "The Issues of the Agricultural Alcohol Industry." Available: http://www.uepa.be/issues.php.
[xi] Biofuels Research Advisory Council. "Biofuels in the European Union: A Vision for 2003 and Beyond." March 14, 2006. Available: http://europa.eu.int/comm/research/energy/pdf/draft_vision_report_en.pdf.
[xii] Available: http://ec.europa.eu/comm/agriculture/capreform/sugar/infopack_en.pdf
[xiii] EC Memo/06/65. "Biofuels Strategy: Background Memo." Available: http://europa.eu.int/rapid/pressReleasesAction.do?reference=MEMO/06/65&format=HTML&aged=0&language=EN&guiLanguage=en
[xiv] The following information is taken directly from GAIN Report E36073: "Sugar Annual 2006."
[xv] International Energy Agency. "Biofuels For Transport: An International Perspective." 2004. Available: http://www.iea.org/textbase/nppdf/free/2004/biofuels2004.pdf
[xvi] EUBIA. "Potential bioethanol yields from common wheat and sugar beet in some of the EU-25 member states." Available: http://www.eubia.org/.
[xvii] [xvii] International Energy Agency. "Biofuels For Transport: An International Perspective." 2004. Available: http://www.iea.org/textbase/nppdf/free/2004/biofuels2004.pdf
[xviii] *Ibid.*
[xix] ADEME/DIREM. " Energy and greenhouse gas balances of biofuels' production chains in France." December 2002. Available: www.ademe.fr/partenaires/agrice/publications/ documents_francais/synthese_bilans_energetiques_fr.pdf.
[xx] "Bioethanol Production Costs in the EU -25 Plus Bulgaria and Romania." European Biomass Industry Association. Bioethanol: Economics. Available: http://www.eubia.org/.
[xxi] "Biofuel Feedstock Markets." F.O. Licht's. World Ethanol and Biofuels Report. 26 April 2006.
[xxii] "Bioethanol Production Costs in the EU-25 Plus Bulgaria and Romania." European Biomass Industry Association. Bioethanol: Economics. Available: http://www.eubia.org/.